

I CLAIM:

1. A shutter switch for an electromagnetic wave beam, comprising:
 - 5 a plurality of waveguides adapted to receive at least part of an electromagnetic beam, said waveguides being adjacent to one another with their longitudinal axes aligned with the propagation of said beam said waveguides switchable to either transmit or block transmission of
 - 10 their respective portions of said beam.

2. The shutter switch of claim 1, wherein each of said waveguides comprises:
 - 5 four wall surfaces comprising two opposing sidewalls and a top and bottom wall;
 - 10 respective high impedance wall structures on at least two opposing walls, said wall structures presenting a high impedance to E fields transverse to the waveguide axis and parallel to the wall structure, and a low impedance parallel to the waveguide axis; and
 - 15 shorting switches on each said wall structures to short circuit their high impedances;
 - each of said waveguides having dimensions to cut-off the transmission of its respective portion of said beam when its high impedance wall structure is short circuited.

3. The shutter switch of claim 2, wherein each said high impedance wall structure comprises:
 - 5 a sheet of dielectric material having two sides;
 - 10 a conductive layer on one side of said dielectric material;
 - 15 a plurality of mutually spaced conductive strips on

the other side of said dielectric material, said strips having gaps between adjacent said strips; and

10 a plurality of conductive vias extending through said dielectric material between said conductive layer and said conductive strips.

4. The shutter switch of claim 3, wherein said conductive strips have a uniform width and are disposed with a uniform gap between adjacent strips.

5. The shutter switch of claim 3, wherein adjacent pairs of said strips present a capacitance and said dielectric sheet presents an inductance to an electromagnetic beam with an E field transverse to said conductive strips.

6. The shutter switch of claim 5, wherein said conductive strips and dielectric material form a series of L-C circuits to an electromagnetic beam with an E field transverse to said conductive strips.

5. The shutter switch of claim 3, wherein said sheet of dielectric material comprises plastic, poly-vinyl carbonate (PVC), ceramic or high resistant semiconductor material.

8. The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's sidewalls and present a high impedance to the E field component of a horizontally polarized beam.

5. The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's top and bottom walls and present a high impedance to the E field component of a vertically polarized signal.

10. The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's sidewalls and top and bottom walls and present a high 10 impedance to the E field component of both horizontally and vertically polarized beams.
11. The shutter switch of claim 3, wherein said shorting switches change said high impedance structure to a conductive surface by shorting said gaps between said 5 conductive strips.
12. The shutter switch of claim 11, wherein said shorting switches comprise micro electromechanical systems (MEMS) switches.
13. The shutter switch of claim 12, wherein each of said MEMS shorting switches comprises a shorting strip suspended over said gap between a respective pair of said conductive 5 strips, said switch being closed by applying a voltage potential to said shorting strip creating an electrostatic tension between it and its respective conductive strips that pulls said shorting strip down to said conductive strips to form a conductive bridge across said gap between 10 said conductive strips.
14. The shutter switch of claim 11, wherein said shorting switches comprise varacter diode switches in each of said gaps.
15. The shutter switch of claim 14, wherein each of said varactor diode shorting switches creates a high capacitance across its respective said gap when a zero voltage applied

5 to said diode to short said gap.

16. The shutter switch of claim 2, wherein said high impedance wall structure comprises:

5 a plurality of stacked high impedance layers, each presenting a high impedance to the E field component of a different respective electromagnetic beam frequency and being transparent to the E fields of lower frequency signals, and presenting a conductive surface to the E field of higher frequency signals; and

10 the bottommost said layer presenting a high impedance to the E field of the lowest frequency of said signals, and each succeeding layer presenting a high impedance to the E field of successively higher frequencies.

17. The shutter switch of claim 16, wherein each of said high impedance layers comprises a substrate of dielectric material having a top and bottom surface and a plurality of 5 conductive strips on said substrate's top surface with gaps between adjacent conductive strips, and further comprising a conductive layer on the bottom surface of the bottommost layer's dielectric substrate.

18. The shutter switch of claim 16, wherein corresponding conductive strips of said high impedance layers are vertically aligned and said high impedance layers further 5 comprise conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

19. The shutter switch of claim 16, wherein said conductive strips on each said layers have uniform widths and uniform gaps between adjacent strips.

20. The shutter switch of claim 16, wherein each of said high impedance layers presents a series of resonant L-C circuits to the E field of its respective signal frequency.
21. The shutter switch of claim 16, wherein the widths of said strips decreases and the width of said gaps between adjacent conductive strips increases with succeeding high 5 impedance layers from the bottommost layer to the topmost.
22. The shutter switch of claim 16, wherein said high impedance wall structures are on said waveguide's sidewalls and present a high impedance to the E field component of 5 said different frequency beams having horizontal polarization.
23. The shutter switch of claim 16, wherein said high impedance wall structures are on said waveguide's top and bottom walls and present a high impedance to the E field 5 component of said different frequency beams having vertical polarization.
24. The shutter switch of claim 16, wherein said high impedance structures are on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E 5 field component of said different frequency beams having both horizontal and vertical polarizations.
25. The shutter switch of claim 16, wherein said shorting switches change said high impedance structure to a conductive surface by shorting said gaps between said 5 conductive strips.

26. The shutter switch of claim 25, wherein said shorting switches comprise micro electromechanical systems (MEMS) switches.

27. The shutter switch of claim 25, wherein each of said MEMS shorting switches comprises a shorting strip suspended over said gap between a respective pair of said conductive strips, said switch being closed by applying a voltage potential to said shorting strip creating an electrostatic tension between it and its respective conductive strips that pulls said shorting strip down to said conductive strips to form a conductive bridge across said gap between 10 said conductive strips.

28. The shutter switch of claim 25, wherein said shorting switches comprise varactor diode switches in each of said gaps.

29. The shutter switch of claim 28, wherein each of said varactor diode shorting switches creates a high capacitance across its respective said gap when a zero voltage applied 5 to said diode to short said gap.

30. The shutter switch of claim 25, wherein said shorting switches are closed on selective layers of said high impedance structures to block transmission one or both 5 polarities of said beam at one or all of said different frequency signals.

31. A millimeter beam transmission system, comprising;
an electromagnetic beam transmitter;
an electromagnetic beam receiver;
5 a shutter switch positioned in the path of said beam

between said transmitter and receiver, said shutter switch comprising at least one waveguide positioned to receive at least part of said beam, the longitudinal axis of each of said waveguides aligned with the propagation of said beam,
10 each of said waveguide being switchable to either transmit or block transmission of its respective portion of said beam.

32. The system of claim 31, wherein said beam transmitter comprises a radiating element for generating a electromagnetic millimeter signal and a first lens
5 positioned to collimate at least part of said millimeter signal into a beam, and said receiver comprises a electromagnetic receiving element and a second lens positioned to focus said beam to said receiving element, said shutter switch positioned between said first and
10 second lenses.

33. The system of claim 31, wherein each said waveguide comprises
5 four wall surfaces comprising two opposing sidewalls and a top and bottom wall;
a high impedance wall structure on at least two opposing walls of said waveguide, said wall structure presenting a high impedance to E fields transverse to the
10 waveguide axis and parallel to the wall structure, and a low impedance parallel to the waveguide axis; and
shorting switches on each said high impedance structure to change the high impedance of said structure to a conductive surface.

34. The system of claim 33, wherein each said waveguide has

dimensions such that the transmission of said electromagnetic beam is cut-off when said waveguide 5 sidewalls and top and bottom walls are conductive surfaces.

35. The system of claim 33, wherein each said high impedance wall structure comprises:

5 a sheet of dielectric material having two sides;
a conductive layer on one side of said dielectric material;
a plurality of mutually spaced parallel conductive strips on the other side of said dielectric material; and
10 a plurality of conductive vias extending through said dielectric material between said conductive layer and said conductive strips.

36. The system of claim 35, wherein said conductive strips have a uniform width, are disposed with a uniform gap between adjacent strips and are parallel to the 5 longitudinal axis of their respective said waveguide.

37. The system of claim 36, wherein said conductive strips, vias and dielectric material form a series of L-C circuits to an electromagnetic wave with an E field 5 transverse to said conductive strips.

38. The system of claim 36, wherein said shorting switches change said high impedance structure to a conductive surface by shorting said gaps between said conductive 5 strips.

39. The system of claim 33, wherein said high impedance wall structure comprises:

5 a plurality of stacked high impedance layers, each

5 presenting a high impedance to the E field component of a different respective electromagnetic beam and being transparent to the E fields of lower frequency signals, and presenting a conductive surface to the E field of higher frequency signals; and

10 the bottommost said layer presenting a high impedance to the E field of the lowest frequency of said signals, and each succeeding layer presenting a high impedance to the E field of successively higher frequencies.

40. The system of claim 39, wherein each said layer presents a series of resonant L-C circuits to the E field of its respective signal frequency.

41. The system of claim 39, wherein each of said high impedance layers comprises a substrate of dielectric material having a top and bottom surface and a plurality of 5 conductive strips on said substrate's top surface, and further comprising a conductive layer on the bottom surface of the bottommost layer's dielectric substrate.

42. The system of claim 39, wherein corresponding conductive strips of said layers are vertically aligned and said high impedance structure further comprises conductive 5 vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

43. The system of claim 39, wherein said shorting switches change said high impedance structure to a conductive surface by shorting said gaps between said conductive 5 strips.

44. The system of claim 33, wherein said high impedance

structure are provided on said waveguide's sidewalls and present a high impedance to an E field component of 5 horizontally polarized beams at one or more frequencies.

45. The system of claim 33, wherein said high impedance structure are provided on said waveguide's top and bottom walls such that said high impedance structure and present 5 a high impedance to an E field component of a vertically polarized beams at one or more frequencies.

46. The system of claim 33, wherein said high impedance structures are provide on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E 5 field component of a horizontally and vertically polarized beams at one or more frequencies.

47. The system of claim 46, wherein said shorting switches are closed on selective layers of said high impedance structures to block transmission one or both polarities of 5 said beam at one or all of said different frequency signals.

48. A method of switching an electromagnetic beam, comprising:

transmitting said beam through one or more waveguides; 5 and

switching the walls of said waveguides between high impedance and conductive states to control the propagation of selected modes of said beam.

49. The method of claim 48, wherein said electromagnetic beam is horizontally polarized and switching the sidewalls of said waveguides between high impedance and conductive

5 states controls the propagation of said beam.

50. The method of claim 48, wherein said electromagnetic beam is vertically polarized and switching the top and bottom walls of said waveguides between high impedance and 5 conductive states controls the propagation of said beam.

51. The method of claim 48, wherein said electromagnetic beam is horizontally and vertically polarized and switching the walls of said waveguides between high impedance and 5 conductive states controls the propagation of said beam.

52. The method of claim 48, wherein said electromagnetic beam is horizontally and vertically polarized, and has different frequencies, the switching of the walls between 5 high impedance and conductive states controls propagation of said beam at different frequencies and polarizations.